TITLE

METHOD FOR DETECTING AND SEPARATING VERTICAL AND HORIZONTAL SYNCHRONOUS SIGNALS FROM A COMPUTER SYSTEM

CLAIM OF PRIORITY

This application makes reference to, incorporates the same herein, and claims all benefits accruing under 35 U.S.C §119 from an application entitled *Method For Detecting And Separating Vertical And Horizontal Synchronous Signals From Computer System* earlier filed in the Korean Industrial Property Office on 21 June 1996, and there duly assigned Serial No. 06-22949 by that Office.

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates in general to a monitor which is used as a video display unit of a computer system, and more particularly to a method for detecting and separating vertical and horizontal synchronous signals from the computer system.

Description of the Prior Art

Generally, the user monitors and checks the operation status of a computer system by means of a monitor. The computer system outputs a signal based on the current operation and the monitor displays the output signal from the computer system on its screen. The monitor utilizes vertical and horizontal synchronous signals to display the output signal from the computer system on the screen.

1   For this reason, the computer system outputs the vertical and horizontal synchronous signals to the

2   monitor together with data to be displayed on the screen of the monitor. The computer system

3   outputs the vertical and horizontal synchronous signals in various manners.

4   For example, the computer system may output the vertical and horizontal synchronous

5   signals separately or as one composite synchronous signal wherein the vertical and horizontal

6   synchronous signals are combined. Alternatively, the computer system may combine the vertical

7   and horizontal synchronous signals on a green color signal and output the resultant one synchronous-

8   on-green (SOG) signal.

9   The monitor must separate the vertical and horizontal synchronous signals from the computer

10   system from each other to use them individually.

11   For this reason, the monitor has to check input forms of the vertical and horizontal

12   synchronous signals from the computer system and separate the vertical and horizontal synchronous

13   signals from each other in accordance with the checked result.

14   The vertical and horizontal synchronous signals from the computer system may be different

15   in polarity.

16   For example, the polarities of the separated vertical and horizontal synchronous signals may

17   be both positive or negative. Alternatively, one of the polarities of the separated vertical and

18   horizontal synchronous signals may be positive and the other may be negative.

19   In the composite synchronous signal, the vertical and horizontal synchronous signals are the

20   same in polarity. Namely, the polarities of the vertical and horizontal synchronous signals are both

21   positive or negative. In the synchronous-on-green signal, the polarities of the vertical and horizontal

22   synchronous signals are both positive.

23   In this connection, the monitor must use hardware to separate and change the polarities of

24   the separated vertical and horizontal synchronous signals suitably for the use therein.

1   As a result, the exemplary monitor requires additional hardware design work for the

2   synchronous signal separator, resulting in increases in manufacturing cost and size of a printed

3   circuit board. For this reason, the manufactured goods are degraded in competitiveness.

SUMMARY OF THE INVENTION

5   Therefore, the present invention has been made in view of the above problems, and it is an

6   object of the present invention to provide a method for detecting and separating vertical and

7   horizontal synchronous signals from a computer system using a microcomputer.

8   In accordance with the present invention, the above and other objects can be accomplished

9   by a provision of a method for detecting and separating vertical and horizontal synchronous signals

10   from a computer system, comprising the first step of scanning a vertical synchronous signal terminal,

11   a horizontal/composite synchronous signal terminal and a synchronous-on-green terminal of the

12   computer system to detect input forms of the vertical and horizontal synchronous signals from the

13   computer system; and the second step of separating the vertical and horizontal synchronous signals

14   from each other in accordance with the input forms detected at the first step and adjusting polarities

15   of the separated vertical and horizontal synchronous signals.

BRIEF DESCRIPTION OF THE DRAWINGS

17   The above and other objects, features and advantages of the present invention will be more

18   clearly understood from the following detailed description taken in conjunction with the

19   accompanying drawings, in which:

20   Fig. 1 is a block diagram illustrating the construction of an exemplary monitor;

21   Figs. 2A to 2C are waveform diagrams of output signals from a computer system in Fig. 1,

22   wherein:

1   Fig. 2A shows vertical and horizontal synchronous signals;

2   Fig. 2B shows a composite synchronous signal; and

3   Fig. 2C shows a synchronous-on-green signal;

4   Fig. 3 is a block diagram illustrating the construction of a monitor in accordance with the

5   principles of the present invention;

6   Fig. 4 is a flowchart schematically illustrating a method for detecting and separating vertical

7   and horizontal synchronous signals from a computer system in Fig. 3 in accordance with the

8   principles of the present invention;

9   Figs. 5A to 5D are flowcharts in detail illustrating a synchronous signal detection step in Fig.

10 4;

11 Fig. 6 is a block diagram illustrating the construction of a microcomputer in Fig. 3 for

12 performing a synchronous signal separation operation in accordance with the principles of the

13 present invention; and

14 Figs. 7A to 7C are timing diagrams illustrating the operation of a vertical synchronous signal

15 detector in Fig. 6.

16 **DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS**

17 Referring to Fig. 1, there is shown in block form the construction of an exemplary monitor.

18 In this drawing, reference numeral 1 designates a computer system such as a personal computer.

19 Computer system 1 outputs red, green and blue color signals at its color signal output terminals R,

20 G and B. Also, computer system 1 selectively outputs a vertical synchronous signal V at its vertical

21 synchronous signal terminal VS, a horizontal synchronous signal H or a composite synchronous

22 signal at its horizontal/composite synchronous signal terminal HCS and a synchronous-on-green

23 signal at its synchronous-on-green terminal SOG.

1   Reference numeral 2 designates a video signal processor. Video signal processor 2 processes

2   the red, green and blue color signals from computer system 1 in response to the vertical and

3   horizontal synchronous signals V and H from computer system 1 and outputs the processed color

4   signals to a cathode ray tube (CRT) 6.

5   Reference numeral 3 designates a synchronous signal separator. Synchronous signal

6   separator 3 separates the vertical and horizontal synchronous signals V and H from computer system

7   1 from each other. Namely, when computer system 1 outputs the vertical and horizontal

8   synchronous signals V and H as shown in Fig. 2A at its vertical synchronous signal terminal VS and

9   horizontal/composite synchronous signal terminal HCS, respectively, synchronous signal separator

10   3 merely adjusts polarities of the vertical and horizontal synchronous signals V and H. On the other

11   hand, when computer system 1 outputs the composite synchronous signal as shown in Fig. 2B at its

12   horizontal/composite synchronous signal terminal HCS or the synchronous-on-green signal as shown

13   in Fig. 2C at its synchronous-on-green terminal SOG, synchronous signal separator 3 separates the

14   composite synchronous signal or the synchronous-on-green signal into the vertical and horizontal

15   synchronous signals V and H and adjusts the polarities of the separated vertical and horizontal

16   synchronous signals V and H.

17   Reference numeral 4 designates a microcomputer. On the basis of frequencies of the vertical

18   and horizontal synchronous signals V and H separated by synchronous signal separator 3,

19   microcomputer 4 determines that the present mode is a video signal output mode of computer system

20   1 and controls the monitor in such a manner that it can be operated in the video signal output mode.

21   Also, microcomputer 4 outputs the vertical and horizontal synchronous signals V and H separated

22   by synchronous signal separator 3 to a synchronous signal processor 5.

23   Synchronous signal processor 5 processes the vertical and horizontal synchronous signals

24   V and H from microcomputer 4 and outputs the processed vertical and horizontal synchronous

1 signals V and H to video signal processor 2. As a result, video signal processor 2 processes the

2 video signal from computer system 1 synchronously with the vertical and horizontal synchronous

3 signals V and H from synchronous signal processor 5.

4 Further, synchronous signal processor 5 controls a magnetic field of a deflection coil 7

5 mounted to CRT 6 so that CRT 6 can display a desired picture in response to an output signal from

6 video signal processor 2. In other words, synchronous signal processor 5 performs horizontal

7 position, horizontal size, vertical position, vertical size, side pin cushion, slope, pin balance and

8 top/bottom corrections with respect to the picture which is displayed by CRT 6.

9 The synchronous signals provided by computer system 1 are classified into the separated

10 vertical and horizontal synchronous signals V and H, the composite synchronous signal and the

11 synchronous-on-green signal. The exemplary monitor comprises synchronous signal separator 3 as

12 hardware means for the separation and polarity adjustment of the synchronous signals from computer

13 system 1.

14 Referring to Fig. 3, there is shown in block form the construction of a monitor in accordance

15 with the present invention. In this drawing, reference numeral 10 designates a computer system.

16 Computer system 10 outputs red, green and blue color signals at its color signal output terminals R,

17 G and B. Also, computer system 10 selectively outputs a vertical synchronous signal V at its vertical

18 synchronous signal terminal VS, a horizontal synchronous signal H or a composite synchronous

19 signal at its horizontal/composite synchronous signal terminal HCS and a synchronous-on-green

20 signal at its synchronous-on-green terminal SOG.

21 The monitor comprises a video signal processor 20 for processing the red, green and blue

22 color signals from computer system 10 in response to the vertical and horizontal synchronous signals

23 V and H from computer system 10, a microcomputer 30 for detecting the vertical and horizontal

24 synchronous signals V and H from the vertical synchronous signal terminal VS,

horizontal/composite synchronous signal terminal HCS and synchronous-on-green terminal SOG of computer system 10, separating the detected vertical and horizontal synchronous signals V and H from each other and adjusting polarities of the separated vertical and horizontal synchronous signals V and H, and a synchronous signal processor 40 for processing the vertical and horizontal synchronous signals V and H from microcomputer 30 and outputting the processed vertical and horizontal synchronous signals V and H to video signal processor 20 so that video signal processor 20 can process the video signal from computer system 10 synchronously with the vertical and horizontal synchronous signals V and H. Further, synchronous signal processor 40 controls a magnetic field of a deflection coil 50 mounted to a CRT 60. CRT 60 deflects electron beams based on an output signal from video signal processor 20 according to the magnetic field of deflection coil 50 controlled by synchronous signal processor 40 to display a desired picture.

The operation of the monitor with the above-mentioned construction in accordance with the present invention will hereinafter be described in detail.

First, computer system 10 outputs red, green and blue color signals of a desired picture to be displayed, at its color signal output terminals R, G and B. Also, computer system 10 selectively outputs the vertical and horizontal synchronous signals V and H at its vertical synchronous signal terminal VS, horizontal/composite synchronous signal terminal HCS and synchronous-on-green terminal SOG.

Microcomputer 30 scans the vertical synchronous signal terminal VS, horizontal/composite synchronous signal terminal HCS and synchronous-on-green terminal SOG of computer system 10 to check input forms of the vertical and horizontal synchronous signals V and H.

Then, microcomputer 30 separates the vertical and horizontal synchronous signals V and H from each other in accordance with the checked input forms and adjusts the polarities of the separated vertical and horizontal synchronous signals V and H.

1   Also, microcomputer 30 determines the present operation mode according to frequencies of

2   the separated vertical and horizontal synchronous signals V and H and controls the monitor in such

3   a manner that it can be operated in the determined operation mode.

4   Synchronous signal processor 40 processes the vertical and horizontal synchronous signals

5   V and H from microcomputer 30 and outputs the processed vertical and horizontal synchronous

6   signals V and H to deflection coil 50 to control the electron beam deflection of CRT 60.

7   Video signal processor 20 processes the red, green and blue color signals from computer

8   system 10 in response to the vertical and horizontal synchronous signals V and H from synchronous

9   signal processor 40 and outputs the processed color signals to CRT 60 to display the desired picture

10   on CRT 60.

11   Fig. 4 is a flowchart schematically illustrating a method for detecting and separating the

12   vertical and horizontal synchronous signals V and H from computer system 10 in Fig. 3 in

13   accordance with the present invention. First, at step S10, microcomputer 30 scans the vertical

14   synchronous signal terminal VS, horizontal/composite synchronous signal terminal HCS and

15   synchronous-on-green terminal SOG of computer system 10 to detect input forms of the vertical and

16   horizontal synchronous signals V and H. Then, at step S20, microcomputer 30 separates the vertical

17   and horizontal synchronous signals V and H from each other in accordance with the input forms

18   detected at the above step S10 and adjusts the polarities of the separated vertical and horizontal

19   synchronous signals V and H.

20   Figs. 5A to 5D are flowcharts in detail illustrating the synchronous signal detection step S10

21   in Fig. 4. First, in Fig. 5A, microcomputer 30 checks at step S100 whether the horizontal

22   synchronous signal H is input from horizontal/composite synchronous signal terminal HCS. If the

23   horizontal synchronous signal H is not input from horizontal/composite synchronous signal terminal

24   HCS at step S100, microcomputer 30 checks at step S210 of step S200 whether the vertical

synchronous signal V is input from vertical synchronous signal terminal VS. If the vertical synchronous signal V is not input from vertical synchronous signal terminal VS at step S210, the microcomputer 30 checks at step S220 of step S200 whether the vertical and horizontal synchronous signals V and H are input from synchronous-on-green terminal SOG.

On the other hand, when the horizontal synchronous signal H is input from horizontal/composite synchronous signal terminal HCS at the above step S100, microcomputer 30 checks at step S300 whether the vertical synchronous signal V is input from vertical synchronous signal terminal VS. If the vertical synchronous signal V is not input from vertical synchronous signal terminal VS at step S300, microcomputer 30 proceeds to step S400 to check whether the composite synchronous signal is input from horizontal/composite synchronous signal terminal HCS.

When the vertical synchronous signal V is input from vertical synchronous signal terminal VS at the above step S300, microcomputer 30 checks the polarity of the horizontal synchronous signal H input from horizontal/composite synchronous signal terminal HCS at step S510 of step S500. In accordance with the polarity checked at step S510, microcomputer 30 proceeds to step S520 or S530 to check whether the composite synchronous signal or the separated vertical and horizontal synchronous signals V and H are input.

At the above step S210, microcomputer 30 checks at step S211 whether the vertical synchronous signal V is input from vertical synchronous signal terminal VS. If the vertical synchronous signal V is input from vertical synchronous signal terminal VS at step S211, microcomputer 30 determines at step S212 that only the vertical synchronous signal V is input from vertical synchronous signal terminal VS with no input of the horizontal synchronous signal H from horizontal/composite synchronous signal terminal HCS. Then, microcomputer 30 performs synchronous signal separation step S20.

On the other hand, when the vertical synchronous signal V is not input from vertical synchronous signal terminal VS at the above step S211, microcomputer 30 proceeds to step S220 to check whether the synchronous-on-green signal is input from synchronous-on-green terminal SOG.

At the above step S220, microcomputer 30 checks at step S221 whether the horizontal synchronous signal H is input from synchronous-on-green terminal SOG. If the horizontal synchronous signal H is not input from synchronous-on-green terminal SOG at step S221, microcomputer 30 determines at step S222 that no synchronous signal is input.

When the horizontal synchronous signal H is input from synchronous-on-green terminal SOG at the above step S221, microcomputer 30 checks at step S223 whether the vertical synchronous signal V is input from synchronous-on-green terminal SOG. If the vertical synchronous signal V is not input from synchronous-on-green terminal SOG at step S223, microcomputer 30 determines at step S224 that only the horizontal synchronous signal H is input from synchronous-on-green terminal SOG with no input of the vertical synchronous signal V. Then, microcomputer 30 performs synchronous signal separation step S20.

However, if the vertical synchronous signal V is input from synchronous-on-green terminal SOG at the above step S223, microcomputer 30 determines at step S225 that the vertical and horizontal synchronous signals V and H are together input from synchronous-on-green terminal SOG and the polarities thereof are both positive. Then, microcomputer 30 performs synchronous signal separation step S20.

At the above step S400 of checking whether the composite synchronous signal is input from the horizontal/composite synchronous signal terminal HCS, as shown in Fig. 5B, microcomputer 30 checks the polarity of the horizontal synchronous signal H input from horizontal/composite synchronous signal terminal HCS at step S410. If the polarity checked at the above step S410 is

1   positive, microcomputer 30 performs a first composite synchronous signal detection operation at step

2   S420. To the contrary, if the polarity checked at the above step S410 is negative, microcomputer

3   30 performs a second composite synchronous signal detection operation at step S430.

4   At the above step S420 of performing the first composite synchronous signal detection

5   operation, microcomputer 30 sets the polarity of the horizontal synchronous signal H to positive at

6   step S421. Also, microcomputer 30 sets the present mode to a vertical synchronous signal extraction

7   mode. Then, microcomputer 30 checks at step S422 whether the vertical synchronous signal V is

8   input from horizontal/composite synchronous signal terminal HCS.

9   When the vertical synchronous signal V is input from horizontal/composite synchronous

10 signal terminal HCS at the above step S422, microcomputer 30 determines at step S423 that the

11 composite synchronous signal is input from horizontal/composite synchronous signal terminal HCS

12 and the polarities of the vertical and horizontal synchronous signals V and H are both positive.

13 Then, microcomputer 30 clamps a back porch of the horizontal synchronous signal H to a reference

14 level of the picture to be displayed on CRT 60 and performs synchronous signal separation step S20.

15 However, when the vertical synchronous signal V is not input from horizontal/composite

16 synchronous signal terminal HCS at the above step S422, microcomputer 30 determines at step S424

17 that only the horizontal synchronous signal H is input from horizontal/composite synchronous signal

18 terminal HCS. Then, microcomputer 30 clamps a front porch of the horizontal synchronous signal

19 H to the reference level of the picture to be displayed on CRT 60 and performs synchronous signal

20 separation step S20.

21 At the above step S430 of performing the second composite synchronous signal detection

22 operation, microcomputer 30 sets the polarity of the horizontal synchronous signal H to negative at

23 step S431. Also, microcomputer 30 sets the present mode to the vertical synchronous signal

1   extraction mode. Then, microcomputer 30 checks at step S432 whether the vertical synchronous

2   signal V is input from horizontal/composite synchronous signal terminal HCS.

3   When the vertical synchronous signal V is input from horizontal/composite synchronous

4   signal terminal HCS at the above step S432, microcomputer 30 determines at step S433 that the

5   composite synchronous signal is input from horizontal/composite synchronous signal terminal HCS

6   and the polarities of the vertical and horizontal synchronous signals V and H are both negative.

7   Then, microcomputer 30 clamps the back porch of the horizontal synchronous signal H to the

8   reference level of the picture to be displayed on CRT 60 and performs synchronous signal separation

9   step S20.

10   However, when the vertical synchronous signal V is not input from horizontal/composite

11   synchronous signal terminal HCS at the above step S432, microcomputer 30 determines at step S434

12   that only the horizontal synchronous signal H is input from horizontal/composite synchronous signal

13   terminal HCS. Then, microcomputer 30 clamps the front porch of the horizontal synchronous signal

14   H to the reference level of the picture to be displayed on CRT 60 and performs synchronous signal

15   separation step S20.

16   At the above step S520 of checking whether the composite synchronous signal or the

17   separated vertical and horizontal synchronous signals V and H are input under the condition that the

18   polarity of the horizontal synchronous signal H checked at step S510 is positive, as shown in Fig.

19   5C, microcomputer 30 sets the polarity of the horizontal synchronous signal H to positive at step

20   S521. Also, microcomputer 30 sets the present mode to the vertical synchronous signal extraction

21   mode. Then, microcomputer 30 checks at step S522 whether the vertical synchronous signal V is

22   input from horizontal/composite synchronous signal terminal HCS.

23   When the vertical synchronous signal V is input from horizontal/composite synchronous

24   signal terminal HCS at the above step S522, microcomputer 30 determines at step S523 that the

13

1 composite synchronous signal is input from horizontal/composite synchronous signal terminal HCS

2 and the polarities of the vertical and horizontal synchronous signals V and H are both positive.

3 Then, microcomputer 30 clamps the back porch of the horizontal synchronous signal H to the

4 reference level of the picture to be displayed on CRT 60 and performs synchronous signal separation

5 step S20.

6 However, when the vertical synchronous signal V is not input from horizontal/composite

7 synchronous signal terminal HCS at the above step S522, microcomputer 30 checks the polarity of

8 the vertical synchronous signal V input from vertical synchronous signal terminal VS at step S524.

9 If the polarity of the vertical synchronous signal V checked at the above step S524 is

10 positive, microcomputer 30 determines at step S525 that the separated vertical and horizontal

11 synchronous signals V and H are input and the polarities thereof are both positive. Then,

12 microcomputer 30 clamps the back porch of the horizontal synchronous signal H to the reference

13 level of the picture to be displayed on CRT 60 and performs synchronous signal separation step S20.

14 When the polarity of the vertical synchronous signal V checked at the above step S524 is

15 negative, microcomputer 30 determines at step S526 that the separated vertical and horizontal

16 synchronous signals V and H are input, the polarity of the vertical synchronous signal V is negative

17 and the polarity of the horizontal synchronous signal H is positive. Then, microcomputer 30 clamps

18 the front porch of the horizontal synchronous signal H to the reference level of the picture to be

19 displayed on CRT 60 and performs synchronous signal separation step S20.

20 At the above step S530 of checking whether the composite synchronous signal or the

21 separated vertical and horizontal synchronous signals V and H are input under the condition that the

22 polarity of the horizontal synchronous signal H checked at step S510 is negative, as shown in Fig.

23 5D, microcomputer 30 sets the polarity of the horizontal synchronous signal H to negative at step

24 S531. Also, microcomputer 30 sets the present mode to the vertical synchronous signal extraction

1   mode. Then, microcomputer 30 checks at step S532 whether the vertical synchronous signal V is

2   input from horizontal/composite synchronous signal terminal HCS.

3   When the vertical synchronous signal V is input from horizontal/composite synchronous

4   signal terminal HCS at the above step S532, microcomputer 30 determines at step S533 that the

5   composite synchronous signal is input from horizontal/composite synchronous signal terminal HCS

6   and the polarities of the vertical and horizontal synchronous signals V and H are both negative.

7   Then, microcomputer 30 clamps the back porch of the horizontal synchronous signal H to the

8   reference level of the picture to be displayed on CRT 60 and performs synchronous signal separation

9   step S20.

10   However, when the vertical synchronous signal V is not input from horizontal/composite

11   synchronous signal terminal HCS at the above step S532, microcomputer 30 checks the polarity of

12   the vertical synchronous signal V input from vertical synchronous signal terminal VS at step S534.

13   If the polarity of the vertical synchronous signal V checked at the above step S534 is

14   positive, microcomputer 30 determines at step S535 that the separated vertical and horizontal

15   synchronous signals V and H are input, the polarity of the vertical synchronous signal V is positive

16   and the polarity of the horizontal synchronous signal H is negative. Then, microcomputer 30 clamps

17   the front porch of the horizontal synchronous signal H to the reference level of the picture to be

18   displayed on CRT 60 and performs synchronous signal separation step S20.

19   When the polarity of the vertical synchronous signal V checked at the above step S534 is

20   negative, microcomputer 30 determines at step S536 that the separated vertical and horizontal

21   synchronous signals V and H are input and the polarities thereof are both negative. Then,

22   microcomputer 30 clamps the front porch of the horizontal synchronous signal H to the reference

23   level of the picture to be displayed on CRT 60 and performs synchronous signal separation step S20.

1   Fig. 6 is a block diagram illustrating the construction of microcomputer 30 in Fig. 3 for

2   performing the synchronous signal separation operation in accordance with the present invention.

3   As shown in this drawing, microcomputer 30 includes a multiplexer 75 for selecting one of the

4   horizontal synchronous signal H or the composite synchronous signal from horizontal/composite

5   synchronous signal terminal HCS and the synchronous-on-green signal from synchronous-on-green

6   terminal SOG in response to a control signal C1, a vertical synchronous signal detector 71 for

7   detecting the vertical synchronous signal V from an output signal from multiplexer 75, a multiplexer

8   76 for selecting the vertical synchronous signal V from vertical synchronous signal terminal VS or

9   from vertical synchronous signal detector 71 in response to a control signal C2, a vertical

10   synchronous signal polarity adjustment unit 72 for adjusting the polarity of the vertical synchronous

11   signal V from multiplexer 76, a horizontal synchronous signal polarity adjustment unit 73 for

12   adjusting the polarity of the horizontal synchronous signal H from multiplexer 76, a synchronous

13   signal oscillator 74 for generating reference vertical and horizontal synchronous signals Vref and

14   Href, a multiplexer 77 for selecting the vertical synchronous signal V from vertical synchronous

15   signal polarity adjustment unit 72 or the reference vertical synchronous signal Vref from

16   synchronous signal oscillator 74 in response to a control signal C3, and a multiplexer 78 for selecting

17   the horizontal synchronous signal H from horizontal synchronous signal polarity adjustment unit 73

18   or the reference horizontal synchronous signal Href from synchronous signal oscillator 74 in

19   response to control signal C3.

20   The synchronous signal separation operation of microcomputer 30 with the above-mentioned

21   construction in accordance with the present invention will hereinafter be described in detail on the

22   basis of the input forms of the vertical and horizontal synchronous signals V and H.

23   1)   When separate vertical and horizontal synchronous signals V and H are input

-15-

In this case, the vertical synchronous signal V is input from vertical synchronous signal terminal VS and the horizontal synchronous signal H is input from horizontal/composite synchronous signal terminal HCS. Multiplexer 75 selects the horizontal synchronous signal H from horizontal/composite synchronous signal terminal HCS in response to control signal C1 and multiplexer 76 selects the vertical synchronous signal V from vertical synchronous signal terminal VS in response to control signal C2. Also, third and fourth multiplexers 77 and 78 select the output signals from vertical and horizontal synchronous signal polarity adjustment units 72 and 73 in response to control signal C3, respectively.

As a result, the vertical synchronous signal V from vertical synchronous signal terminal VS is selected by multiplexer 76, adjusted in polarity by vertical synchronous signal polarity adjustment unit 72 and then output through multiplexer 77. Also, the horizontal synchronous signal H from horizontal/composite synchronous signal terminal HCS is selected by multiplexer 75, adjusted in polarity by horizontal synchronous signal polarity adjustment unit 73 and then output through multiplexer 78.

2)   When the composite synchronous signal is input

In this case, the composite synchronous signal is input from horizontal/composite synchronous signal terminal HCS. Multiplexer 75 selects the composite synchronous signal from horizontal/composite synchronous signal terminal HCS in response to control signal C1 and multiplexer 76 selects the output signal from vertical synchronous signal detector 71 in response to control signal C2. Also, multiplexers 77 and 78 select the output signals from vertical and horizontal synchronous signal polarity adjustment units 72 and 73 in response to control signal C3, respectively.

As a result, the composite synchronous signal from horizontal/composite synchronous signal terminal HCS is selected by multiplexer 75 and then applied to vertical synchronous signal detector 71, which detects the vertical synchronous signal V from the composite synchronous signal.

Noticeably, vertical synchronous signal detector 71 can detect the vertical synchronous signal V from the composite synchronous signal in various manners. In the preferred embodiment of the present invention, vertical synchronous signal detector 71 utilizes a 5-bit counter to detect the vertical synchronous signal V from the composite synchronous signal, as will hereinafter be described in detail.

When multiplexer 75 selects the composite synchronous signal as shown in Fig. 7A from horizontal/composite synchronous signal terminal HCS, vertical synchronous signal detector 71 up-counts a clock signal (not shown) for a high level duration of the composite synchronous signal and down-counts the clock signal for a low level duration of the composite synchronous signal, as shown in Fig. 7B.

Vertical synchronous signal detector 71 generates a count within the range of "00000" to "11111". At this time, no underflow occurs when the count is below "00000" and no overflow occurs when the count is above "11111". Vertical synchronous signal detector 71 outputs a high level signal when the count is "11111".

In result, as shown in Fig. 7C, vertical synchronous signal detector 71 outputs a low level signal for a narrow pulse width interval of the horizontal synchronous signal H of the composite synchronous signal from multiplexer 75 because the count is below "11111" and a high level signal for a wide pulse width interval of the vertical synchronous signal V of the composite synchronous signal because the count is "11111".

1   The vertical synchronous signal V detected by vertical synchronous signal detector 71 is

2   selected by multiplexer 76, adjusted in polarity by vertical synchronous signal polarity adjustment

3   unit 72 and then output through multiplexer 77.

4   On the other hand, the composite synchronous signal from horizontal/composite synchronous

5   signal terminal HCS is used directly as the horizontal synchronous signal H. As a result, the

6   composite synchronous signal from horizontal/composite synchronous signal terminal HCS is

7   selected by multiplexer 75, adjusted in polarity by horizontal synchronous signal polarity adjustment

8   unit 73 and then output as the horizontal synchronous signal H through multiplexer 78.

9   3)   <u>When the synchronous-on-green signal is input</u>

10   In this case, the synchronous-on-green signal is input from synchronous-on-green terminal

11   SOG. Multiplexer 75 selects the synchronous-on-green signal from synchronous-on-green terminal

12   SOG in response to control signal C1 and multiplexer 76 selects the output signal from vertical

13   synchronous signal detector 71 in response to control signal C2. Also, multiplexers 77 and 78 select

14   the output signals from vertical and horizontal synchronous signal polarity adjustment units 72 and

15   73 in response to control signal C3, respectively.

16   As a result, the synchronous-on-green signal from synchronous-on-green terminal SOG is

17   selected by multiplexer 75 and then applied to vertical synchronous signal detector 71, which detects

18   the vertical synchronous signal V from the synchronous-on-green signal in a similar manner to the

19   case where the composite synchronous signal is input.

20   The vertical synchronous signal V detected by vertical synchronous signal detector 71 is

21   selected by multiplexer 76, adjusted in polarity by vertical synchronous signal polarity adjustment

22   unit 72 and then output through multiplexer 77.

1   Also, the synchronous-on-green signal from synchronous-on-green terminal SOG is selected

2   by multiplexer 75, adjusted in polarity by horizontal synchronous signal polarity adjustment unit 73

3   and then output as the horizontal synchronous signal H through multiplexer 78.

4   4)   When no Synchronous signal is input

5   In this case, microcomputer 30 outputs separate vertical and horizontal synchronous signals.

6   In other words, synchronous signal oscillator 74 is operated, and multiplexers 77 and 78 select the

7   output signals from synchronous signal oscillator 74 in response to control signal C3, respectively.

8   As a result, the reference vertical and horizontal synchronous signals Vref and Href from

9   synchronous signal oscillator 74 are output through multiplexers 77 and 78, respectively.

10   As apparent from the above description, according to the present invention, the input forms

11   of the vertical and horizontal synchronous signals from the computer system are discriminated in the

12   software manner employing the microcomputer. In accordance with the discriminated input forms,

13   the vertical and horizontal synchronous signals are separated from each other and then adjusted in

14   polarity. Therefore, the present invention requires no separate hardware for the separation and

15   polarity adjustment of the vertical and horizontal synchronous signals, resulting in simplification in

16   circuit construction and reductions in number of used components and size of a printed circuit board.

17   Although the preferred embodiments of the present invention have been disclosed for

18   illustrative purposes, those skilled in the art will appreciate that various modifications, additions and

19   substitutions are possible, without departing from the scope and spirit of the invention as disclosed

20   in the accompanying claims.